CH. 3 Practice

1. An element, E, has only two naturally occurring isotopes. E-10 has a mass of 10.01 amu and a natural abundance of 19.78%. E-11 has a mass of 11.01 amu and a natural abundance of 80.22%. What is the average atomic mass of E?

$(10.01)(.1978) = 1.980$

$(11.01)(.8022) = 8.832$

10.812 amu

2. Chlorine has two stable isotopes. The mass of one isotope is 34.97 amu. Its relative abundance is 75.53%. What is the mass of the other stable isotope?

$[(34.97)(.7553)] + [(x)(.2447)] = 35.45$

$[(x)(.2447)] = 35.45 - 26.41$

$[(x)(.2447)] = 9.04$

$x = 36.94 \text{ amu}$

3. How many atoms are in 2.4 moles of neon gas? How many grams?

$\frac{2.4 \text{ mol Ne}}{1} \cdot \frac{6.022 \times 10^{23} \text{ atoms}}{1 \text{ mol Ne}} = 1.4 \times 10^{24} \text{ atoms Ne}$

4. How many grams of zinc are in 1.16×10^{22} atoms of zinc?

$\frac{1.16 \times 10^{22} \text{ atoms Zn}}{1} \cdot \frac{1 \text{ mole Zn}}{6.022 \times 10^{23} \text{ atoms Zn}} \cdot \frac{65.38 \text{ g Zn}}{1 \text{ mol Zn}} = 1.26 \text{ g Zn}$

5. How many mg of Br_2 are 4.6×10^{20} molecules of bromine?

$\frac{4.6 \times 10^{20} \text{ molecules } Br_2}{1} \cdot \frac{1 \text{ mol } Br_2}{6.022 \times 10^{23} \text{ m'cules } Br_2} \cdot \frac{159.80 \text{ g } Br_2}{1 \text{ mol } Br_2} \cdot \frac{1000 \text{ mg}}{1 \text{ g } Br_2} = 120 \text{ mg } Br_2$

6. How many grams are there in 0.36 moles of cobalt (III) acetate, $Co(C_2H_3O_2)_3$? How many grams of cobalt are in the sample? How many atoms of cobalt?

$$\frac{.36 \text{ moles } Co(C_2H_3O_2)_3}{1} \cdot \frac{236.08 g}{1 \text{ mol } Co(C_2H_3O_2)_3} = 85 g\ Co(C_2H_3O_2)_3$$

$$\frac{.36 \text{ mol Co}}{1} \cdot \frac{58.93 g}{1 \text{ mol Co}} = 21 g\ Co$$

$$\frac{.36 \text{ mol Co}}{1} \cdot \frac{6.022 \times 10^{23} \text{ atoms Co}}{1 \text{ mol Co}} = 2.2 \times 10^{23} \text{ atoms}$$

7. Calculate the mass percent of chlorine in each of the following compounds.

A. ClF

$$\frac{35.45}{54.45} \times 100 = 65.11\% \ Cl$$

B. $CuCl_2$

$$\frac{70.90}{134.45} \times 100 = 52.73\% \ Cl$$

$$\frac{\text{g chl a}}{\text{mole chl a}} ?$$

$$\left(\frac{2.72 g \ Mg}{100 g \text{ chl a}}\right)$$

8. Chlorophyll a is essential for photosynthesis. It contains 2.72% magnesium by mass. What is the molar mass of chlorophyll a assuming there is one atom of magnesium in every molecule of chlorophyll a?

$$\left(\frac{1 \text{ atom Mg}}{1 \text{ molec. chl a}}\right)$$

↓ so...

$$\left(\frac{1 \text{ mole Mg}}{1 \text{ mole chl a}}\right)$$

$$\frac{1 \text{ mol Mg}}{1 \text{ mol chl a}} \cdot \frac{24.30 \cancel{g\ Mg}}{\cancel{1 \text{ mol Mg}}} \cdot \frac{100 g \text{ chl a}}{2.72 \cancel{g\ Mg}} = 893 g/mol$$

9. Which of the following formulas can be empirical? Circle them.

A. CH_4
B. CH_2
C. $KMnO_4$
D. N_2O_5
E. B_2H_8 → BH_4
F. NH_4Cl
G. Sb_2S_3
H. N_2O
I. CH_2O

lowest whole # ratio of atoms

10. A compound is found to contain 49.67 % carbon, 48.92 % chlorine, and 1.39 % hydrogen. The molar mass of the compound is 289.9 g/mole. Determine the empirical and molecular formulas of the compound.

p119-120
69
71
73
75
77

$$\frac{49.67 g\ C}{1} \cdot \frac{1 \text{ mol C}}{12.01 g} = \frac{4.136 \text{ moles}}{1.376} = 3$$

$$\frac{48.92 g\ Cl}{1} \cdot \frac{1 \text{ mol Cl}}{35.45 g} = \frac{1.380 \text{ moles}}{1.376} = 1$$

$$\frac{1.39 g\ H}{1} \cdot \frac{1 \text{ mol H}}{1.01 g} = \frac{1.376 \text{ moles}}{1.376} = 1$$

Emp. formula: C_3ClH

↓

Emp. mass 72.49 g

$289.9 \div 72.49 = 4$

Molecular formula: $C_{12}Cl_4H_4$

11. Calcium carbonate decomposes upon heating, producing calcium oxide and carbon dioxide.

A. Write a balanced chemical equation for this reaction.

$$CaCO_{3(s)} \xrightarrow{\Delta} CaO_{(s)} + CO_{2(g)}$$

B. How many grams of calcium oxide will be produced after 12.25 grams of calcium carbonate are completely decomposed?

$$\frac{12.25 g\ CaCO_3}{1} \times \frac{1\ mole\ CaCO_3}{100.09 g\ CaCO_3} \times \frac{1\ mol\ CaO}{1\ mol\ CaCO_3} \times \frac{56.08 g\ CaO}{1\ mol\ CaO} = 6.864\ g\ CaO$$

C. What is the volume of carbon dioxide gas produced when the 12.25 grams of calcium carbonate completely decompose at STP?

$$\frac{12.25 g\ CaCO_3}{1} \times \frac{1\ mol\ CaCO_3}{100.09 g\ CaCO_3} \times \frac{1\ mol\ CO_2}{1\ mol\ CaCO_3} \times \frac{22.4 L\ CO_2}{1\ mol\ CO_2} = 2.74 L\ CO_2$$

12. When ammonia gas, oxygen gas and methane (CH_4) gas are combined, the products are hydrogen cyanide gas and water.

A. Write a balanced chemical equation for the reaction.

$$2NH_{3(g)} + 3O_{2(g)} + 2CH_{4(g)} \rightarrow 2HCN_{(g)} + 6H_2O$$

B. Calculate the mass of each product produced when 225 grams of oxygen gas is reacted with an excess of the other two reactants.

$$\frac{225 g\ O_2}{1} \times \frac{1\ mol\ O_2}{32.00 g\ O_2} \times \frac{2\ mol\ HCN}{3\ mol\ O_2} \times \frac{27.03 g\ HCN}{1\ mol\ HCN} = 127\ g\ HCN$$

$$\frac{225 g\ O_2}{1} \times \frac{1\ mol\ O_2}{32.00 g\ O_2} \times \frac{6\ mol\ H_2O}{3\ mol\ O_2} \times \frac{18.02 g\ H_2O}{1\ mol\ H_2O} = 253 g\ H_2O$$

C. If the actual yield of the experiment in (B) is 105 grams of HCN, calculate the percent yield.

$$\%\ Yield = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100 \qquad \frac{105}{127} \times 100 = 82.7\ \%\ \text{yield}$$

13. DDT, an insecticide harmful to fish, birds and humans, is produced by the following reaction: MM = 112.55 MM = 147.38 MM = 354.46

$$2C_6H_5Cl + C_2HOCl_3 \rightarrow C_{14}H_9Cl_5 + H_2O$$

chlorobenzene chloral DDT

In a government lab, 1142 grams of chlorobenzene is reacted with 485 grams of chloral.

A. What mass of DDT is formed?

$$\frac{1142\,g\,C_6H_5Cl}{1} \times \frac{1\,mol\,C_6H_5Cl}{112.55\,g\,C_6H_5Cl} \times \frac{1\,mol\,DDT}{2\,mol\,C_6H_5Cl} \times \frac{354.46\,g\,DDT}{1\,mol\,DDT} = 1798\,g\,DDT$$

$$\frac{485\,g\,chloral}{1} \times \frac{1\,mol\,chloral}{147.38\,g\,chloral} \times \frac{1\,mol\,DDT}{1\,mol\,chloral} \times \frac{354.46\,g\,DDT}{1\,mol\,DDT} = 1170\,g\,DDT$$

Theoretical yield

B. Which reactant is limiting? Which is excess?

$C_2HOCl_3 \Rightarrow LR$

$C_6H_5Cl \Rightarrow ER$

LR ER

C. What mass of the excess reactant is left over?

$$\frac{485\,g\,C_2HOCl_3}{1} \times \frac{1\,mol\,C_2HOCl_3}{147.38\,g\,C_2HOCl_3} \times \frac{2\,mol\,C_6H_5Cl}{1\,mol\,C_2HOCl_3} \times \frac{112.55\,g\,C_6H_5Cl}{1\,mol\,C_6H_5Cl} = 741\,g\,C_6H_5Cl\ used$$

1142 g available − 741 g used = 401 g excess

D. If the actual yield of DDT is 200.0 grams, what is the percent yield?

$$\frac{200.0\,g}{1166\,g} \times 100 = 17.15\%\ yield$$

RICE chart solution

RICE → moles or Pressure

13.

	ER	LR		
	~~1142 g~~	485 g		
	MM = 112.55 g	MM = 147.38 g	MM: 354.46	
R	$2C_6H_5Cl$ +	C_2HOCl_3 →	$C_{14}H_9Cl_5$ +	H_2O
I	10.14 moles	3.29 moles	0	0
*C	− 6.58	− 3.29	+ 3.29	+ 3.29
E	3.56	0	3.29 moles	3.29

A) 1166 → 1170 g $C_{14}H_9Cl_5$ → TY

C) 401 g C_6H_5Cl excess

$$\%\text{Yield} = \frac{AY}{TY} \times 100$$

$$= \frac{200.0\,g}{1170\,g} \times 100 = 17.1\%$$